

15th Space Simulation Conference

*Support the Highway to Space
Through Testing*

(NASA-CP-3015) FIFTEENTH SPACE SIMULATION
CONFERENCE: SUPPORT THE HIGHWAY TO SPACE
THROUGH TESTING (NASA) 492 F CSCL 22B

N89-12582
--THRU--
N89-12620
Unclass
0172310

H1/18

*Proceedings of a symposium held at
Williamsburg Hilton and National Conference Center,
Williamsburg, Virginia
October 31 to November 3, 1988*



15th Space Simulation Conference

*Support the Highway to Space
Through Testing*

Sponsored by
National Aeronautics and Space Administration
Institute of Environmental Sciences
The American Institute for Aeronautics and Astronautics
The American Society for Testing and Materials

*Proceedings of a symposium held at
Williamsburg Hilton and National Conference Center,
Williamsburg, Virginia
October 31 to November 3, 1988*



National Aeronautics
and Space Administration

Scientific and Technical
Information Branch

1988

PREFACE

The Fifteenth Space Simulation Conference, held at the Williamsburg Hilton and National Conference Center, Williamsburg, Virginia, October 31 to November 3, 1988, is hosted by the Institute of Environmental Sciences (IES) and supported by the American Institute of Aeronautics and Astronautics (AIAA) and the American Society for Testing Materials (ASTM). The conference is further supported by the National Aeronautics and Space Administration (NASA) by their publication of these proceedings.

Some thirty years ago, man was able to reach out and touch space for the first time using the tools of technology to understand this new frontier. Soon after, the first meeting of the Space Simulation Conference, or the Tri-Society as it was initially referred, came into existence. Today, the Fifteenth Space Simulation Conference represents a gathering of respected individuals presenting papers to "Support the Highway to Space Through Testing." And the papers presented at this conference and the resulting discussions again will continue to carry on our ability for a permanent presence in space.

I would like to take this opportunity to publicly thank a few of those people whose efforts have made this conference and the publication of this document possible. Thanks go to Richard (Dick) Hartenbaum, Technical Program Chairman, GE Astro Space Division, and his people on the technical committee; Joseph (Joe) Stecher III, Publication Chairman, NASA Goddard Space Flight Center; and John D. Campbell, IES Meeting Manager, for bringing us to Williamsburg. In addition, the program committee would like to express our special thanks to Janet A. Ehmann, Executive Director, Institute of Environmental Sciences, and her staff for handling all the details which ensured a successful conference.

I wish all of you success and hope this conference will become as valued an experience as it has for me.

Albert R. Lunde
General Chairman

PRECEDING PAGE BLANK NOT FILMED

**COMMITTEES FOR
15TH SPACE SIMULATION CONFERENCE**

MEETING MANAGEMENT COMMITTEE

General Chairman:	Albert R. Lunde, Boeing Aerospace Company
Technical Program:	Richard Hartenbaum, GE Astro Space Division
IES Meeting Manager:	John D. Campbell, Consultant
Publication Chairman:	Joseph L. Stecher III, NASA Goddard Space Flight Center
Facilities Chairman:	Russell T. Hollingsworth, Consultant
IES Executive Director:	Janet A. Ehmann, Institute of Environmental Sciences

TECHNICAL PROGRAM COMMITTEE

Eugene N. Borson, The Aerospace Corporation
Peter W. Brinkman, ESA/ESTEC
John W. Harrell, Jet Propulsion Laboratory
Raymond D. Rempt, Boeing Aerospace Company
George F. Wright, Jr., Sandia National Laboratories
George Mikk, Perkin-Elmer Corporation
Robert P. Parrish, Jr., Martin Marietta Corporation
Richard Shoulberg, GE Astro Space Division

JOINT POLICY COMMITTEE

IES

John D. Campbell, Consultant
George Frankel, Grumman Aerospace

ASTM

Eugene N. Borson, The Aerospace Corporation
George F. Wright, Jr., Sandia National Laboratories

AIAA

George Mikk, Perkin-Elmer Corporation
Doug McKenney, Boeing Aerospace Company

CONTENTS

Page

SESSION I: CONTAMINATION I

Chairman: Eugene N. Borson, The Aerospace Corporation
Co-Chairman: Captain Carol Moreland, Rome Air Development Center

WF/PC INTERNAL MOLECULAR CONTAMINATION DURING SYSTEM THERMAL-VACUUM TEST	1
D. Taylor, J. Barengoltz, T. Jenkins, K. Leschly, and J. Triolo, California Institute of Technology	
WIDE FIELD/PLANETARY CAMERA (WF/PC) CONTAMINATION CONTROL ASSESSMENT	11
C. Maag, J. Millard, and M. Anderson, California Institute of Technology	
CHARACTERIZATION OF A GRAPHITE EPOXY OPTICAL BENCH DURING THERMAL VACUUM CYCLING	12
P. Hansen, D. Taylor, T. Jenkins, and C. Maag, California Institute of Technology	

SESSION II: CONTAMINATION II

Chairman: Eugene N. Borson, The Aerospace Corporation
Co-Chairman: Captain Carol Moreland, Rome Air Development Center

CLASS 100 LARGE SPACECRAFT FACILITY	29
L. E. Ryan, TRW Operations & Support Group	
CORRELATION STUDIES ON SURFACE PARTICLE DETECTION METHODS	30
R. V. Peterson and J. C. White, Hughes Aircraft Company	
PRECISION CLEANING METHODS FOR SPACECRAFT APPLICATIONS	47
L. E. Ryan and H. Lindewall, TRW Operations & Support Group	

SESSION III: ATOMIC OXYGEN

Chairman: Raymond Rempt, Boeing Aerospace Company
Co-Chairman: Jon Cross, Los Alamos National Laboratories

THE NASA ATOMIC OXYGEN EFFECTS TEST PROGRAM	51
Bruce A. Banks, Sharon K. Rutledge, and Joyce A. Brady, NASA/Lewis Research Center	
MATERIALS SELECTION FOR LONG LIFE IN LEO: A CRITICAL EVALUATION OF ATOMIC OXYGEN TESTING WITH THERMAL ATOM SYSTEMS	66
S. L. Koontz, J. Kuminecz, L. Leger, and P. Nordine, NASA/Johnson Space Center	

ATOMIC OXYGEN STUDIES ON POLYMERS	89
W. D. Morison, R. C. Tennyson, J. B. French, and T. Braithwaite, University of Toronto, Institute for Aerospace Studies; and M. Moisan and J. Hubert, Université de Montréal	
ATOMIC OXYGEN EFFECTS ON CANDIDATE COATINGS FOR LONG-TERM SPACECRAFT IN LOW EARTH ORBIT	110
E. H. Lan and C. A. Smith, McDonnell Douglas Astronautics Company; and J. B. Cross, Los Alamos National Laboratory	

SESSION IV: DYNAMIC TESTING

Chairman: Richard Shoulberg, GE Astro Space Division
Co-Chairman: Charles G. Krisch, GE Astro Space Division

PYRO SHOCK SIMULATION: EXPERIENCE WITH THE MIPS SIMULATOR	125
Thomas J. Dwyer and David S. Moul, GE Astro Space Division, Valley Forge, PA	
MULTIPLE INPUT/OUTPUT RANDOM VIBRATION CONTROL SYSTEM	139
James F. Unruh, Southwest Research Institute	
THE FLIGHT ROBOTICS LABORATORY	158
Patrick A. Tobbe, Marlin J. Williamson, and John R. Glaese, Control Dynamics Company	
SPACE STATION DOCKING MECHANISM DYNAMIC TESTING	168
Thomas G. Howsman and John R. Glaese, Control Dynamics Company	

SESSION V: SPACE SIMULATION I

Chairman: Robert Parrish, Martin Marietta Corporation
Co-Chairman: Dean Chambers, Martin Marietta Corporation

SPACE SIMULATORS FOR LASER OPTICS	179
Frank H. Gardner, Tenney Engineering, Inc.	
DEVELOPMENT OF A TWO AXIS MOTION SIMULATION SYSTEM FOR THERMAL/VACUUM SATELLITE TESTING	187
David Henderson, Bert Popovich, Louis DeMore, and Joe Elm, Contraves Goerz Corporation	
LIGO VACUUM SYSTEM STUDY	206
Jeffrey C. Livas, Massachusetts Institute of Technology; and Boude C. Moore, California Institute of Technology	
THE TWO AXIS MOTION SIMULATOR FOR THE LARGE SPACE SIMULATOR AT E.S.T.E.C.	221
Kurt A. Beckel and Joop Hutchison, European Space Research and Technology Centre (ESTEC)	

	Page
INDIAN LSSC FACILITY	235
A. S. Brar, High Vacuum Equipment Corp.; V. S. Prasada Rao, Bharat Heavy Plate & Vessels, Ltd.; and R. D. Gambhir and M. Chandramouli, ISRO Satellite Center	

SESSION VI: SPACE SIMULATION II

Chairman: John Harrell, Jet Propulsion Laboratory
Co-Chairman: Alda Simpson, NASA/Goddard Space Flight Center

THERMAL/STRUCTURAL DESIGN VERIFICATION STRATEGIES FOR LARGE SPACE STRUCTURES	241
David Benton, The Analytic Sciences Corp.	
IRIS THERMAL BALANCE TEST WITHIN ESTEC LSS	253
Piero Messidoro and Marino Ballesio, AERITALIA SAIPA Space System Group; and J. P. Vessaz, ESA/ESTEC	
THE INSTRUMENT TEST DEWAR: TESTING SATELLITE INSTRUMENTS AT 1.5 K	268
Laura J. Milam, NASA/Goddard Space Flight Center	
SOLAR SIMULATION WITH A RECTANGULAR BEAM	278
O. G. Feil and H. U. Frey, IABG, Munich, West Germany	
CONTROL OF THE INDUCED MICROGRAVITY ENVIRONMENT OF THE MAN TENDED FREE FLYER	289
Juergen Schlund, MBB-ERNO, Bremen, West Germany	

SESSION VII: LAUNCHER FACILITIES

Chairman: Peter Brinkmann, ESA
Co-Chairman: J. Herholz, ESA/Toulouse

SIMULATION OF THE EFFECTS OF THE ORBITAL DEBRIS ENVIRONMENT ON SPACECRAFT	311
M. D. Bjorkman, Boeing Aerospace Company	
A STEAM INERTING SYSTEM FOR HYDROGEN DISPOSAL FOR THE VANDENBERG SHUTTLE	312
Stuart B. Belknap, The Aerospace Corporation	
TEST STAND DESIGN AND ANALYSIS FOR TITAN 34D STATIC FIRING	336
Shayan Pazargadi, Wyle Laboratories	
TEST STAND FOR TITAN 34D SRM STATIC FIRING	353
Vladimir Glozman, California Polytechnic University; and George Shipway, Wyle Laboratories	

ARIANE 5 VERIFICATION AND ASSOCIATED TEST FACILITIES	368
M. Vedrenne and A. L. Gonzalez, ESA Headquarters, Paris	
THE SEPARATION TEST IN VACUUM OF THE ARIANE 4 PAYLOAD FAIRING	372
J. R. Butcher, Contraves AG, Zurich	

SESSION VIII: ANALYTICAL EXPERIMENTAL HEAT TRANSFER

Chairman: George F. Wright, Jr., Sandia National Laboratories

Co-Chairman: R. E. Sheldahl, Sandia National Laboratories

THE SOLAR SIMULATION TEST OF THE ITALSAT THERMAL STRUCTURAL MODEL	395
M. Giommi, S. Liverani, and G. P. Santin, Selenia Spazio, Rome, Italy	
DEVELOPMENT OF OPTIMIZED, GRADED-PERMEABILITY AXIAL GROOVE HEAT PIPES	397
Michael R. Kapolnek and H. Rolland Holmes, Lockheed Missiles and Space Company, Inc.	
HEAT PIPE COOLING SYSTEM WITH SENSIBLE HEAT SINK	409
Calvin C. Silverstein, CCS Associates	

SESSION IX: THERMAL CONTROL COATINGS AND MEASUREMENTS

Chairman: George Mikk, Perkin-Elmer Corporation

Co-Chairman: Thomas J. Best, U.S.A.F. - Arnold A.F.S.

REQUIRMENTS AND TEST RESULTS FOR THE QUALIFICATION OF THERMAL CONTROL COATINGS	419
J. E. Brzuskiwicz and G. A. Zerlund, DSET Laboratories, Inc.;	
L. Kauder and G. M. Miller, NASA/Goddard Space Flight Center	
COMPARISON OF SULFURIC AND OXALIC ACID ANODIZING FOR PREPARATION OF THERMAL CONTROL COATINGS FOR SPACECRAFT	437
Huong G. Le, John M. Watcher, and Charles A. Smith, McDonnell Douglas Corporation	
MOISTURE INTERACTION AND STABILITY OF ZOT THERMAL CONTROL SPACECRAFT COATING	452
Gordon R. Mon, Charles C. Gonzalez, Ronald G. Ross, Jr.,	
Liang C. Wen, and Timothy O'Donnell, Jet Propulsion Laboratory	
COST EFFECTIVE ALTERNATIVE TO LOW IRRADIANCE MEASUREMENTS	466
Scott T. O'Leary, Martin Marietta Astronautics Group, Space Systems Company	
TEST DATA ACQUISITION SYSTEM FOR THE ESTEC LARGE SOLAR SIMULATOR AT ESA/ESTEC	476
G. Buroni, Carlo Gavazzi Space, Milano, Italy; and	
L. Zucconi, ESA/ESTEC, Noordwijk, The Netherlands	

Session I

CONTAMINATION I